THINKING SMALL

The Future of Nanotechnology in the Forest Products Industry

by Kathy Price-Robinson

Like the revolution launched when plywood hit the market a century ago, another engineered wood revolution looms on the horizon.

This time, the engineering will happen on a very small scale — that of atoms and molecules rearranged to make old products work better, and to make new products out of common materials, such as lignocelluloses, the cells that make up wood. The science is called nanotechnology, referring to particles the size of nanometers, which are one-billionth of a meter and take 100,000 to create the thickness of a sheet of paper.

The new technology is considered to be in the "pre-competitive" stage according to the National Nanotechnology Initiative (NNI), a federal research and development program established to coordinate multiagency efforts in nanoscale science, engineering and technology. That means its application is limited.

But products benefiting from this new science are already on the market, including better-performing tennis balls, sunscreens and cosmetics, ink, dental-bonding agents, burn and wound dressings, and stain-free fabrics. You know those magical Dockers trousers that don't stain? You can thank nanotechnology for that.

Within two to five years, the NNI predicts, nanotechnology will bring about advanced drug delivery systems, including implantable devices that automatically administer drugs; medical diagnostic tools, such as cancer tagging mechanisms; cooling chips or wafers to replace compressors in cars, refrigerators, air conditioners and other devices, utilizing no chemicals or moving parts; sensors for airborne chemicals or other toxins; and photovoltaics (solar cells), fuel cells and portable power to provide inexpensive, clean energy.

Obviously, the forest products industry will benefit directly from these advances, particularly advances in solar and other alternative energies.

As for the forest products sector specifically, nanotechnology promises revolution in two areas: things done *to* wood products (preservatives, sealants, adhesives, etc.) and things done *with* wood fibers (new materials to replace non-renewable metals, ceramics and plastics).

"Nanotechnology represents a major opportunity to generate new products and industries in the coming decades," says a 100-page report created by the U.S. Forest Products Laboratory (FPL) with 110 researchers and scientists weighing in on the topic.

The report, titled *Vision and Technology Roadmap*, points out that the U.S. has a massive infrastructure in place for growing, harvesting and processing wood products, and if those wood products became the renewable, sustainable building blocks for a new generation of materials, the industry would become revitalized and strengthen its global economic competitiveness.

But costly research will be needed to bring this vision forward, and strategic partnerships are necessary between the government, academia and industry, the *Roadmap* says.

Other industries have a head start. The NNI has made $1 billion available for research this year to such industries as pharmaceuticals, computers and chemical companies. However, virtually none of the NNI funds have gone directly to the forest products industry.

Worldwide, another $3 billion is spent annually on nanotechnology research, which breaks down to $1 billion each for Europe and Japan, and $1 billion for the rest of the world, as estimated by the Nano Science and Technology Institute. At this rate, the forest products industry could not be considered an "early adopter" in nanotechnology. "A lot of the work in

nanotechnology is at the university level," said Alan Potter, executive director of Forest Research Opportunity, BC. " As a sector, we're really trying to catch up. The forest products industry has quite a bit of homework to do."

According to Ted Wegner, assistant director of FPL, the industry must take advantage of research done outside the industry, and channel some of those research dollars to the industry." We'd like to see more nanotechnology research focused on the forest products sector," Wegner said. "We have to go out and create the opportunities."

Thanks to funding from the NNI, intensive research in nanotechnology is taking place at 13 universities, including the University of Washington, Center for Nanotechnology; Pennsylvania State University at the Nanofabrication Facility; Georgia Institute of Technology, at the Microelectronics Research Laboratory, and University of Michigan, at the Solid State Electronics Laboratory.

Last year, Forintek Canada Corp. and the National Research Council commissioned a study to determine the opportunities for nanotechnology in the wood products sector. Here are some of the findings, according to the time anticipated to bring advancements about:

0-5 Years

Composite materials, laminates, resins: The study found this an important area "to develop high-value products and better use of wood resources" with high payback for development efforts invested. In fact, it is the chemical companies who are doing most of the nanotechnology research and development that will benefit engineered wood products, according to Potter.

Fire safety, structural safety: This is a critical area in terms of competing with steel and cement for construction materials. Nanotechnology allows fire-resistant particles to be imbedded more deeply into wood than ever before. And nanotechnologies will allow new materials made from lignocellulose to be stronger yet lighter than ever before.

Moisture control: This is another critical improvement that can make wood products even more competitive. Ever since early in the 20th century when plywood was used for automobile running boards, and then rejected in favor of moisture-impervious metal, solving engineered wood's moisture issues has been a long process of study and improvement. These new technologies bring the problem closer to a solution.

UV Protection and Pest Control: According to the study, "UV protection is one of the hottest topics in wood products development today." Potter agrees, saying that maintaining the aesthetic appeal of wood products in outdoor conditions without the need for maintenance is "the holy grail" for wood product manufacturers. The ability to imbed atomic-sized particles in wood makes that possible. And, as FPL's Wegner points out: "You don't have to use a lot of nanoproducts to get an effect."

This year, researchers at Michigan Technical University licensed rights to chemical company Philbro-Tech to patents for taking wood additives, including those containing copper, down to the nanoscale and impregnating them into wood.

"The current generation of wood treatment products, while free from the harmful effects of arsenic and chrome, do not have the same leaching characteristics as the previous generation of CCA products," said Dwight Glover, Phibro-Tech's president, in a press release. "The MTU patents stand at the forefront of a technology that will significantly reduce leaching, while continuing to protect wood in a cost-effective manner."

5-11 Years

New wood products: Eventually, with further breakthrough technology on the nanoscale, new wood products not even on the horizon will be developed. Food products could conceivably be developed from woody waste.

New materials: The most potentially revolutionary development for the wood products industry would be the creation of new materials from lignocellulose that rival the strength and lightness of metals and plastics, and yet come from a completely renewable and sustainable raw material.

Energy generation. Someday, Wegner said, all windows and walls and roofs on homes will be energy generators. And imagine nanoparticles inserted into coatings that can change the color of a roof for solar advantage—light in the summer, dark in the winter.

The future of nanotechnologies benefiting the forest products sector will depend on funds committed by all stakeholders. So far, government and universities are doing most of the heavy lifting.

"I'd like to see more industry leadership," said Wegner. "We haven't had a lot of folks stepping up."

To those who doubt a bright future for nanotechnology innovation, Potter is reminded of President Kennedy's goal to reach the moon by the end of the 1960s. At the time, no one knew how it would be done. Likewise the goal to use wood fibers to solve many of the world's problems is a destination that needs a road map.

"It's a vision," Potter said. ■

Kathy Price-Robinson is a freelance writer who writes about the construction and building products industries.